Predisturbance Watershed Assessment Manual

Alberta
Forest Service

PREDISTURBANCE
WATERSHED ASSESSMENT MANUAL

by

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PREFACE

This manual was prepared by the Forest Land Use Branch in cooperation with the Timber Management Branch and the Forests. This was in response to the expressed need to have a method of incorporating watershed management concerns into Annual Operating Plan (AOP) development.

The watershed assessment is intended to be completed before development of the AOP in areas where required. The sensitivity of an area, both politically and environmentally, will dictate the need for an assessment.

A Postdisturbance Assessment Procedure is being developed as a follow-up document to the Predisturbance Assessment Procedure.

1. INTRODUCTION

Serious erosion, reduced water quality and increased reclamation costs can originate from poorly planned logging operations and road construction. Many of these problems can be avoided by knowing the extent and type of sensitive areas and having recommendations to manage these sites. Watershed assessments are a tool that allows watershed management concerns to be incorporated into the timber harvest planning process.

1.1 What is a Watershed Assessment?

A watershed assessment is an evaluation of the terrain and drainage conditions of a watershed before timber harvesting. This assessment provides direction to minimize impact on the watershed through the development of an Annual Operating Plan (AOP). Proposed operating areas are inspected for such things as sensitive water source areas and erosion prone sites.

1.2 What Does an Assessment Provide?

Good AOPs are developed from a sound resource data base. The assessment provides resource data base for watershed concerns. Information on watershed sensitivity is gathered and the following information is mapped at an operational scale of 1:15 000:

1) Water source areas, seepages and springs
2) Steep and inoperable areas
3) Highly erodible sites
4) Accurate location of ephemeral and intermittent streams

The watershed assessment assists AOP development by identifying critical sites where detailed cutblock plans are required, and inoperable areas. The assessment does not currently address other aspects of watershed management such as water quantity, timing and measurement of water quality. Further documents regarding these elements are under development for later presentation.

1.3 What Does the Final Product Look Like?

The most important feature of the assessment is a 1:15 000 operational map that clearly indicates areas of operating concern. Additional relevant details about specific areas of operating concern and a list of recommendations are included in the accompanying report. Copies of this assessment will be retained by the AFS and the company.

1.4 Are There Different Types of Watershed Assessments?

Assessments can be conducted to inventory many factors. This procedure is intended for use prior to timber harvesting to assess the sensitive areas of a watershed. For consistency, a standard provincial approach is used although the amount of detail in the assessment may vary depending on the location.

With a standard assessment both government and industry should be evaluating sites in a similar fashion.

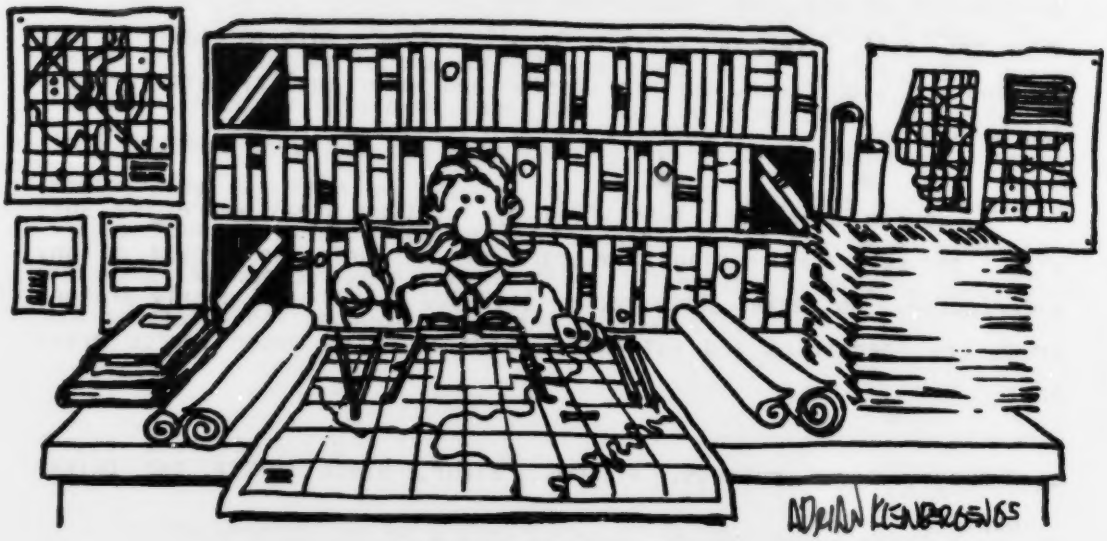
1.5 How Is a Watershed Assessment Carried Out?

There are three steps in completing a watershed assessment:

1) Research Phase
   - Review of background information
   - Identification of sensitive areas from map and aerial photograph interpretation
2) Field Phase
   - Ground truthing the research phase
   - Identification of site specific problems
3) Reporting Phase
   - Production of summary document and map (1:15 000)

2. WATERSHED ASSESSMENT METHODOLOGY

2.1 Phase I: Research and Office Preparation Phase



This portion of the assessment is the gathering and interpretation of background information prior to conducting the field survey. It determines what areas are potentially the most sensitive and directs the field survey to those areas for a closer look. The success of the field survey depends on how thoroughly the initial stages of the assessment were completed. Watershed assessments inventory four site factors; water source areas, steep areas, highly erodible soils, and stream identification and classification, and maps them on a Phase 3 base map.

2.1.1 Water Source Areas

Water source areas are areas where the soils are saturated or surface flow is occurring, and where water is being contributed directly into a watercourse. For this reason water source areas need protection.

Protection of source areas does not necessarily mean the trees may not be harvested. The key to water source area management is the maintenance of the lower vegetation and duff layers (LFH, Of, Om, Oh). With the duff layer or surface layers intact, mineral soil is not exposed and significant surface erosion and water quality deterioration can be avoided.

Source areas are identified by locating areas where the soil will be saturated during some part of the unfrozen period on any watercourse. On aerial photography (1:15 000 - 1:20 000) poorly drained areas are identified and outlined. Indicators of water source areas are:

- Muskegs, treed muskegs, willows, alder, black spruce and balsam poplar.
- Areas within 20 m of any watercourse.
- Seepages, springs and other water emergence areas.
- Flood plains and wet areas between river breaks.

Aerial photograph interpretation of water source areas is tricky. Experience is the best teacher.

2.1.2 Steep Areas - Slopes

There are four stratifications for slope:

i) 0 to 24% - Usually normal operating guidelines apply

ii) 25 to 44% - Detailed cutblock planning (1:5 000) may be required by the company

iii) 45% and greater - Conventional falling and skidding is not permitted

iv) Where sustained slopes of greater than 15% encroach on protective buffer - Detailed planning (1:5 000) may be required by the company

If NTS topographic contour lines are on the Phase 3 maps, it is necessary to roughly locate where steep areas are occurring. The use of contour lines on Phase 3 maps may not be completely accurate for 1:15 000 but they are the best readily available information. Aerial photographs can then be used to give a more accurate measurement of slope. See Appendix. Very accurate contour maps can be obtained from Resource Evaluation And Planning (REAP). They should only be considered for special areas because of limited availability.

2.1.3 Erodible Soils

The erodibility of a site is based on four major factors:

1) The steepness and length of the slope
2) The amount and type of vegetation
3) The soil moisture content.
4) The propensity for the soil material to erode

The assessment considers slope factors, source areas (moisture status) and assumes full vegetation cover. What remains is the actual erodibility of a given material. This is easily handled in an assessment by looking for exceptions. For most areas, the normal operating guidelines will apply. The exceptions which need to be mapped include:

1) Aeolian deposits. These are commonly remnant sand dunes with some established vegetation. Once disturbed, this material is easily eroded.
2) Shallow colluvium and saprolitic material. Shallow soils require special consideration because any soil loss from this thin layer might directly affect site productivity.
3) Other areas considered erodible based on the assessor's familiarity and local experience of the region.

Soil reports and surficial geology maps can be used to locate these materials. A watershed forester can assist in mapping these areas and making recommendations.

2.1.4 Erosion Features

Using aerial photographs, verify the location of steep areas previously determined from the topographic map. Examine these areas with a stereoscope for any signs of slope failure.

Closely examine any areas denuded of vegetation. Naturally occurring bare areas can indicate gullying, mass wasting, blowdown or other signs of surface failure. The scale of the photographs will only permit the identification of major areas of failure. Smaller problem areas will be located during the field survey.

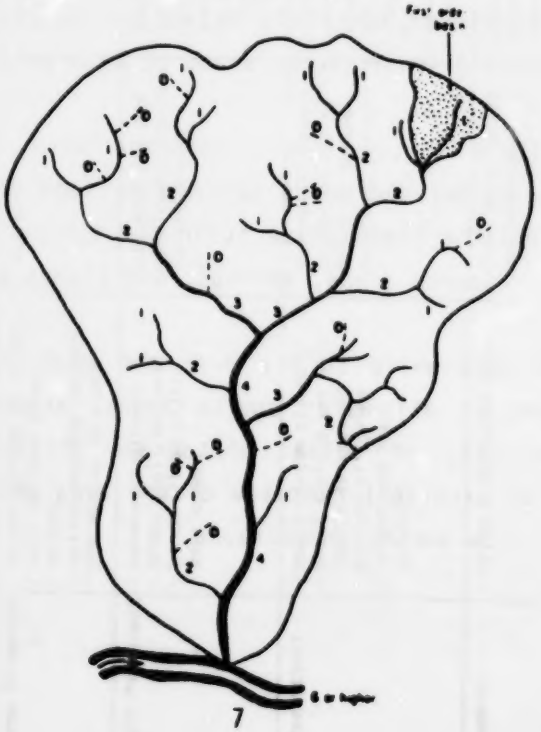
Map all watercourses, paying particular attention to areas of channel instability. On the photograph mark all signs of channel braiding, meander scars, cutoffs, oxbows, slumps, bank failure and fallen trees. Areas of previous land use activity should be closely examined as they will indicate the sensitivity of the areas. Stream crossings, whether they are roads, seismic or transmission lines and pipelines, should be inspected to see whether they were properly installed and whether they cross perpendicular to the watercourse. Future crossings may experience similar problems.

2.1.5 Stream Course Mapping

Phase 3 maps accurately map the location of larger streams; however, some additional aerial photograph interpretation is needed to map smaller watercourses. Small tributaries, springs and seepages should be carefully mapped.

Strahler's Stream Order Classification can be used to initially determine the watercourse classification used in the Alberta Planning and Harvesting Ground Rules. It is a tool for users unfamiliar with an area and requiring an initial assessment on the classification of a stream. First order streams are usually intermittent or ephemeral, second and third order, small permanent and fourth order and greater are usually large permanent. The classification begins by numbering all non-branching channels on a Phase 3 map as a first order creek. When two first order streams meet, the channel becomes a second order stream; when two second order streams meet, the channel becomes third order and so on. Fig. 1 shows how the classification is completed.

Fig. 1 Stream Order Classification



1:15 000

Zero ("0") order streams are interpreted from aerial photographs and then transferred to the Phase 3 maps. Table 1 outlines which order corresponds generally to the watercourse classification. The important point is to map the location; classification of the watercourse is done during the field phase.

2.2 Phase II: Field Survey Phase

The purpose of the field survey is to ground truth those areas identified as being sensitive or areas of watershed management concern.

The field survey should coincide with snow-free conditions. Areas such as slumps and seeps may not be seen under snow cover. The best time to do the field phase is in the spring or just after a large rain when water source areas, springs, and slumps are most evident.

It is worthwhile to fly over the area before the ground work begins to look at all water source areas, steep slopes and streams. Check for accuracy of aerial photograph interpretation and access. Flying gives an excellent overview of the area which is not possible on the ground or from aerial photographs.

TABLE 1

WATERCOURSE CLASSIFICATION

Watercourse Classification	Physical Description	Portion of Year Water Flows	Channel Development	Land Use Impact	Fisheries Concerns	Map Classification (Strahler System) (1:15000 scale
Large Permanent	- major streams or rivers - well defined flood plains - valley usually exceeds 400 metres in width	- all year	- unvegetated channel width greater than 5 metres	- water quality often reflects all upstream land use impacts and natural erosion processes	- resident fisheries (most important of entire fisheries habitat)	- 4th order and above
Small Permanent	- permanent streams - often small valleys - bench (flood plain) development	- all year but may completely freeze in the winter	- banks and channel well defined - gravel and rubble usually present in channel - channel width 0.5 to 5 metres	- water quality - fisheries populations sensitive to siltation	- significant insect populations - spawning and seasonal habitat during higher flow periods - resident fish populations in larger streams	- 2nd to 3rd order
Intermittent	- small stream channels - small springs are main source outside of periods of spring runoff and heavy rainfall	- during wet season or during storms - dries up during season of drought	- distinct channel development - usually channel is non-vegetated - channel width to 0.5 metres - some bank development	- deposition of sediment during flow periods will damage fish and invertebrate habitat and effect higher order streams into which it flows	- production area for important food sources - drift invertebrate populations in pools and riffles - blockages prevent fish passage for spawning	- 0-1st order
Ephemeral	- often a vegetated draw	- flows only during and immediately after rainfall or snowmelt	- little or no channel development - channel is usually vegetated	- sediment production during flow periods as a result of soil disturbance	- only as influence on water quality downstream	- 0 order - not identified on maps

2.2.1 Water Source Areas

Field inspection can usually confirm whether a water source area is present. Indicators of water source areas that can be seen in the field are:

1) Vegetation present. Plants such as alder, black spruce, larch, Sphagnum, sedges, bog birch, Ledum, bog rosemary, bog cranberry and balsam poplar.
2) Areas of slumping and seepages where water flows into any watercourse.
3) Water emergence areas.

2.2.2 Steep Areas - Slopes

The accuracy of mapping slopes is greatly improved during the field phase. Check as many slopes as possible using a clinometer. Mark the location and slope on the aerial photographs. After the field work has been completed, go back to the photos and check the aerial photograph interpretation.

2.2.3 Erosion Prone Areas

On the map, investigate and identify zones of lateral channel instability. That is:
- cut offs
- oxbow lakes
- abandoned channels
- meander scars
- braided channels
- undercut banks
- meandering watercourses

These features are indicative of changes in channel configuration and may be undesirable as stream crossing sites.

Indicate areas that show signs of being flooded from:

- high water marks - debris caught in trees
- surface flow through the trees
- signs of scouring/deposition

Areas susceptible to blowdown should be identified on the base map. These are areas where rooting depth has been reduced and there is insufficient structural strength to prevent windthrow. Factors that promote shallow rooting include:

- inherent shallow root formation
- shallow groundwater table
- presence of shallow bedrock layers
- water saturation of soil layers
- insufficient soil aeration
- steep slopes
- hardened soil layers that impede rooting (Bridges and Davidson 1982)

Areas of slope failure should be identified during the survey;

1) Soil creep - a slow, almost imperceptible downward movement of the soil strata on a slope. It often occurs in hummocky rolling topography and in areas with springs or poor internal drainage. Creep is often localized below wet areas and its presence can be indirectly indicated by leaning poles or geotropically affected trees (i.e., curved to remain oriented with gravity).

2) Slumping - slumps can be easily identified in the field and occur where the support at the base of a slope has been removed, such as along road cuts, or stream banks. They can also occur when the shear strength of a slope is exceeded, perhaps by overloading a slope with fill material.

3) Landslides - includes debris slides and avalanches. Generally, landslides occur in steep terrain where shallow soils overlie bedrock.

These features are mapped to identify areas of instability because disturbance may cause further erosion. For example, logging a slump area may increase soil moisture and therefore increase the susceptibility to slumping.

2.2.4 Stream Course Mapping

The location of a watercourse is done by aerial photograph interpretation, while classification is done in the field phase. Ground truth as many streams as possible. Accurate mapping is required because many of the timber harvesting guidelines are based on the watercourse classification. Table 1 (Page 10) gives the physical description for each classification.

2.3 Phase III: Reporting Phase

The final step in producing a watershed assessment is to assimilate the resource information gathered and provide direction on minimizing harvesting disturbance. In the Reporting Phase, sensitive areas are mapped onto a Phase 3 map and a report is prepared that provides direction on how these concerns should be incorporated.

2.3.1 Drafting of Final Map

All information gathered during the Research and Field Phases is combined to produce a final assessment map. Sensitive areas are mapped onto .004 matte overlay (similar to Phase 3 dylars) at a 1:15 000 scale according to the legend in Table 2. The mapping of the assessment information on an overlay allows the assessment map to be mated with the appropriate Phase 3 dylar and multiple blueline copies made. In cases where the watershed assessment extends over multiple townships, the assessment overlay should be cut accordingly, mated to the appropriate Phase 3 dylar, and the blueline copies joined.

2.3.2 Report Preparation

Accompanying the map is a brief report that assesses site conditions, resource concerns and management implications of the area. The report identifies critical sites where detailed cutblock plans (1:5 000) will be required and makes general recommendations on the timing of operations, cutblock size and shape, road alignment,

Table 2 WATERSHED ASSESSMENT LEGEND

STREAMS	• LARGE PERMANENT	
	• SMALL PERMANENT	
	• INTERMITTENT AND EPHEMERAL	
WATER SOURCE AREAS	• SEEPAGES • SPRINGS • POORLY DRAINED AREAS	
SLOPES	• 0-24%	NOT SHADED
	• 25-45% AND >15% SLOPES ENCROACHING WATERCOURSES	
	• 45%+	
EROSION PRONE AREAS	• SLOPE FAILURE-SLUMPS, CREEP, LANDSLIDES • BLOW DOWN AREAS • ZONES OF LATERAL CHANNEL INSTABILITY	
ERODIBLE SOILS	• AEOLIAN DEPOSITS • COLLUVIUM • SAPROLITIC MATERIAL	

harvesting systems and equipment and reforestation treatments. The watershed assessment recommendations should be developed to incorporate the concerns from other resource sectors. These include aesthetics, wildlife, recreation and timber harvesting. For example, timber harvesting to the stream edge may not cause stream sedimentation, but may be in conflict with wildlife objectives.

Listed below are some examples of ground rules (in italics) addressing watershed management concerns with appropriate recommendations. Note that the wording for F.M.A. ground rules may differ.

2.3.2.1 Detailed Cutblock Plans (1:5 000)

Ground Rule:

1. *Slope, soil, timber volume and equipment contemplated, must all be considered when planning logging operations, reforestation treatment, and reclamation on steep slopes to ensure soil disturbance, erosion and watercourse sedimentation are kept to an acceptable minimum.*
   The intensity of planning required shall be in accordance with the complexity and sensitivity of the site conditions and the degree of disturbance expected.

2. *Appropriate harvesting methods shall be used and detailed cutblock plans with the Annual Operating Plan for logging, reforestation and reclamation shall be provided on sensitive sites. Areas considered sensitive include:*

   (a) sustained slopes exceeding 25 per cent,

   (b) where sustained slopes encroach on protective watercourse buffers that are approved for harvest and will affect timber extraction or reforestation,

(c) cutblocks containing a high density of drainages, springs, unstable soils or otherwise designated as sensitive.

3. *No harvesting of slopes steeper than 45 per cent should be conducted by conventional ground skidding equipment. Alternative harvesting methods, such as tracked skidding and cable yarding, should be considered to remove timber from slopes exceeding 45 per cent.*

Recommendation:

The Detailed Cutblock Plan is not an assessment but rather a harvest strategy which adequately deals with the sensitive areas previously identified in the watershed assessment. Detailed cutblock planning is the responsibility of the timber operator and should address harvesting, reforestation and reclamation. It should be submitted when determined as necessary for sensitive or critical areas identified during the cruise and preliminary plan stages. Detailed cutblock plans should follow the approved preliminary Annual Operating Plan and be prepared during the field layout stage.

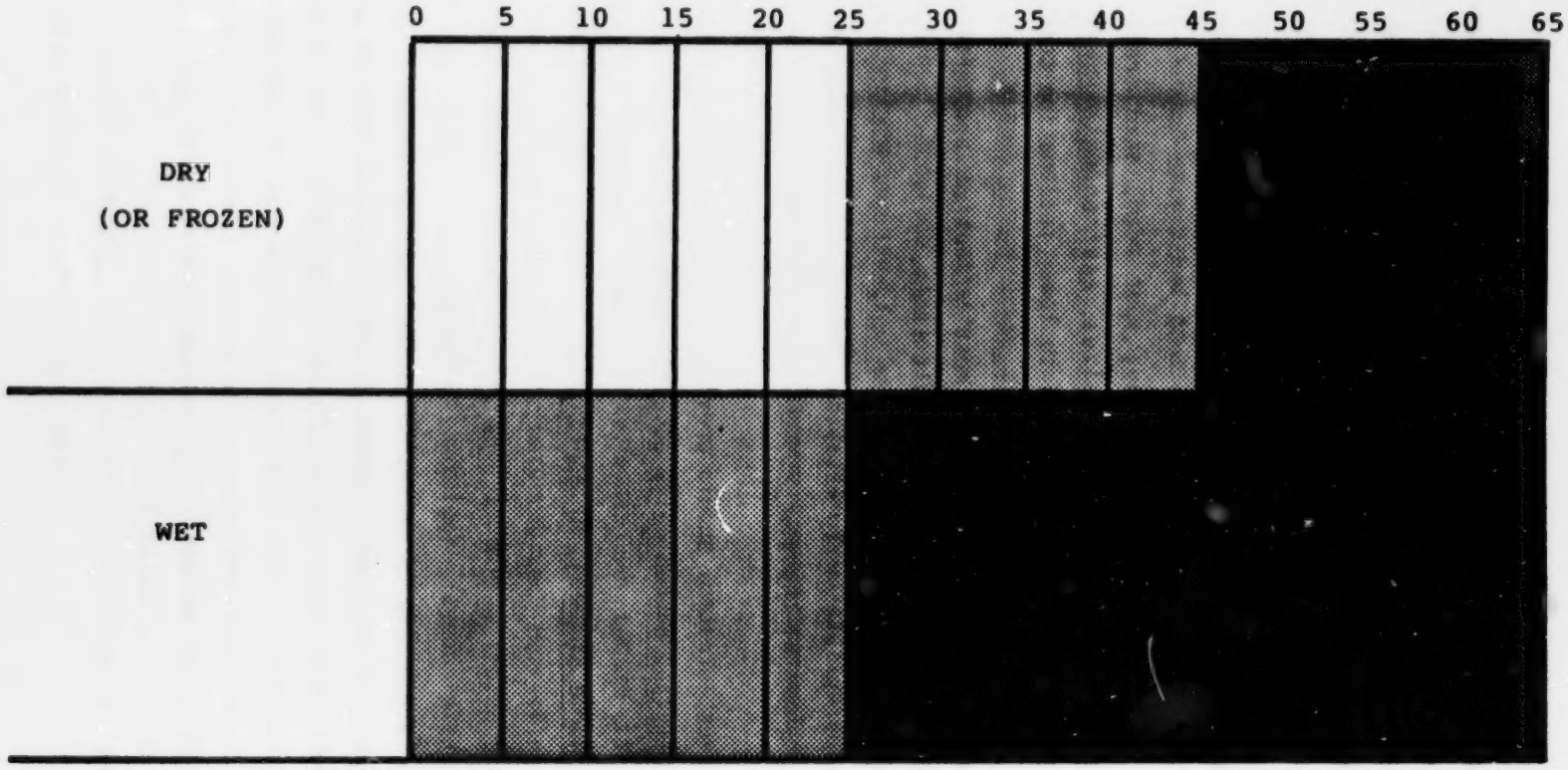
Generally, detailed cutblock planning may be required for slopes greater than 25 per cent and in extensive water source areas. In some cases, sensitive soils and a high drainage density may be factors to consider. The Erosion Hazard Chart (Fig. 2) can be used to assist when detailed plans are required. The detailed plans are generally required for the moderate rating.

Detailed cutblock plans are a 1:5 000 hand drawn map that are prepared by enlarging the appropriate Phase 3 map. The following information is mapped:

- location of roads, landings and main skid trails,
- skidding direction,
- location of streams and classification,
- location, size and type of watercourse crossings,
- location of springs, seepages and water source areas,
- location of steep slopes, unstable and sensitive soils,

EROSION HAZARD CHART

Figure 2



LOW	Normal operating ground rules usually apply.
MODERATE	Appropriate harvesting methods should be used and detailed cutblock plans prepared. Reforestation and reclamation plans should be prepared with the Annual Operating Plan.
HIGH	Alternative harvesting methods such as tracked skidding and cable yarding should be considered to remove timber.

- location of protective buffers for watercourses, water source areas, wildlife habitat, and aesthetic values.

The level of planning will depend on the complexity and sensitivity of the terrain.

Benefits of the detailed cutblock plan:

1. The plan will result in cutblock road, spur road, skid trail and decking locations that best minimizes environmental impact. Decreased site disturbance translates into lower reclamation costs.

2. Detailed planning ensures that the most effective and efficient harvest strategy is employed on difficult sites.

3. It ensures appropriate reforestation treatment is selected to decrease environmental change.

The detailed harvest strategy should provide a plan that is operationally, environmentally and economically acceptable.

2.3.2.2 Water Source Areas

Ground Rule:

. ***Water source areas may be operated during dry or frozen periods subject to specific operating conditions and submission of a detailed cutblock plan. Operations are restricted to these periods in order to avoid disturbance to the duff layer and exposure to the mineral soil. Spur roads which are required to extract timber shall only be constructed in water source areas during snow covered and frozen periods.***

- *Scarification treatment will be permitted within a water source area or the high water mark of any watercourse during dry or frozen periods, provided that disturbance is kept to a minimum by spot scarifying or other appropriate methods. Equipment must be kept away from the watercourse and the banks must not be disturbed.*
  Scarification equipment shall only be permitted to cross a watercourse at improved crossings, or during frozen periods to protect the banks and stream bed from disturbance.

Recommendations:

Water source areas are very sensitive to disturbance and need protection. Buffers are a means of addressing these site-specific concerns. Accurate mapping and ground truthing of water source areas will indicate the location and extent of buffers required for watershed protection. Additional buffers may be required for other concerns such as wildlife corridors and stream temperature maintenance for fish habitat.

The key to water source area management is the maintenance of the duff layer. Water source areas can become saturated and very susceptible to erosion. Disturbance in these wet areas generally means sediment will be added into the watercourse. Harvesting operations that do not disturb the duff layer, such as during frozen ground conditions, are acceptable but detailed cutblock layout plans are required. Internal access, skid trails and landing locations must be identified in the detailed plan and should avoid these sensitive areas. The plans should ensure that timber is skidded away from water source areas rather than across.

Logging, reforestation and reclamation costs in source areas may be higher. Reforestation may be difficult and the sensitivity to disturbance is high. The costs of logging some of these areas can be greater than the value of the timber.

Severe scarification, such as blade scarification, must be avoided in water source areas. Spot scarification or other less severe methods are acceptable.

2.3.2.3 Cutblock Size

Ground Rule:

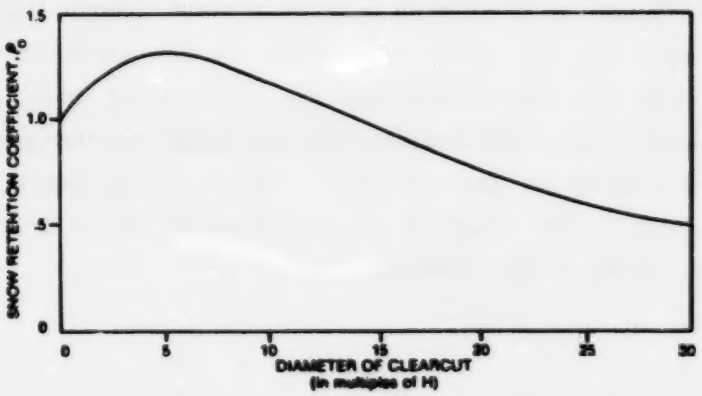
The microclimate of the proposed cutover must be considered. Special measures should be taken where there is a need to conserve moisture.

Recommendation:

Large cutblocks promote wind scouring of the snow pack which could result in moisture stress for regeneration.

Areas where snow pack management is a priority, such as chinook prone area, can be managed in several ways. The amount of snow in a cutblock is a function of the windward length of the cutblock and the height of the surrounding trees. Windward length of a clearing is measured parallel to the predominant wind direction and expressed as a multiple of the height (H) of trees surrounding the clearing. Figure 3 illustrates this point, (Troendle and Leaf 1980).

Figure 3. Snow Retention as a Function of Clearcut Width



The greatest amount of snow accumulation occurs at about 5 H. Assuming a 20 m tree height of the adjacent stand and square cutblocks, this translates into a cutblock size of about one hectare. The key here is not the size of the cutblock but its width perpendicular to winter precipitation patterns. To manage for snow accumulation, cutblocks should be less than 15 H. If cutblocks are greater than 15 H, removal of timber on the second cycle creates additional problems. With the two metre rule applied, the effective size of the cutblocks are significantly greater than 15 H. For example, a 200 m wide cutblock with 2 m regeneration in the adjacent stand, results in a 100 H cut. In a cutblock this size, wind scouring of snow can be extensive. Wind scouring and blowing snow may be a contributing factor to the lack of success in reforesting.

Even with the loss of snow there still might be an increase in the water table in the cutblock after harvest. This is because clearcuts have a lower evapotranspiration rate than forested lands.

Surface roughness (slash or regeneration height, etc.) has an influence on snow accumulation, especially on cutblocks greater than 15 H. Brush and debris left on the cutblock act as wind breaks or snow fences which collect snow. In cutblocks greater than 15 H, wind scouring of snow is significant. The amount of scouring is inversely proportional to the roughness in the cutblock. In the middle of a large cutblock with 30 cm of debris, the wind will scour away the snow to that 30 cm level. By doubling the height of the slash, the amount of snow may also be doubled. To promote soil moisture conservation (especially in cutblocks greater than 15 H), debris, slash, and brush should be left in the clearcut.

2.3.2.4 Roads and Stream Crossings

Ground Rule:

Roads, skid trails and landings shall be located in a manner which minimizes soil disturbance and watercourse impacts by ;

a) avoiding unstable areas, water source areas, springs and seepages; and

(b) following natural benches, moderate slopes, and ridges to minimize cuts and fills.

Recommendations:

The number of stream crossings, road lengths and the number of roads should be minimized. The Annual Operating Plan should be carefully reviewed to ensure that unnecessary crossings and roading are avoided. Cutblock location, road layout and cutting sequence are all factors which can contribute to more crossings than required. At least 90% of the sediment entering a stream is from roads and stream crossings (Anderson et. al. 1976). Fewer roads means fewer problems.

New roads contribute the largest amount of sediment into a stream. Use existing access whenever possible to reduce the amount of sediment entering a stream. An additional benefit may be reduced construction costs.

Road alignments should fit the topography. Align roads along the contour to reduce the amount of cut and fill. This should decrease the impact of road development to the watershed.

2.3.2.5 Cutblock Design

Ground Rule:

Cutblock boundaries should be designed to follow natural terrain features, contours and timber type boundaries where possible to minimize the impact on watershed, blowdown and aesthetics; and to benefit wildlife, silviculture and harvesting logistics.

Recommendations:

Lay out cutblocks between watercourses. Use streams and water source areas as cutblock boundaries whenever possible. This has the effect of minimizing stream crossings as well as protecting the stream from disturbance. If the cutblock is not bounded by a stream and both sides of the stream are cut, there is a greater risk of uncontrolled crossing and skidding. If only one side of the stream is logged and the other side is a leave or reserve block, then protection is generally assured.

The cutblocks should be dispersed over the entire watershed. That is, cutblocks should be on dissimilar aspects and elevations to release the water from the watershed out of synchronization.

2.3.2.6 Cutblock Sequencing

Recommendation:

Cutblock sequencing will determine how long roads, crossings and areas of disturbance remain in place. Erosion and water quality problems are seasonal and cutblock sequencing should consider the ground conditions at the expected time of operations.

Cutblocks with unstable soils, steep slopes, draws, water source areas, seepages or slumps should be avoided until frozen ground conditions. Winter operations in these sensitive areas may need to be delayed.

Summer operations should be planned to harvest the wetter cutblocks during the driest times. Operations should be deferred if the site becomes too wet.

2.3.2.7 Flexibility of Recommendations. Become familiar with the ground rules and their intent. *The ground rules* (and the assessment) *are to be applied with sound judgment, practical experience, and technical competence.*

Let the assessments provide the resource information to support your recommendations.

3.0 CONCLUDING COMMENT

Watershed management does not end with completion of the watershed assessment. Follow-up is required to ensure that the concerns have been adequately addressed. "Ultimately, the impact of forest practice on soil and water rests with the operator, no matter how good the plan or how sound the information on which it was based" (Brown and Beschta 1985).

Appendix

Per cent Slope Chart for 1:50 000 and 1:15 000 Topographic Maps (contour interval - 50 feet)

	% SLOPE	DISTANCE BETWEEN CONTOUR LINES (mm) (1 CONTOUR INTERVAL)		DISTANCE FOR 5 CONTOUR LINES (mm) (4 CONTOUR INTERVAL)		DISTANCE FOR 10 CONTOUR LINES (mm) (9 CONTOUR INTERVAL)	
		1:50K	1:15K	1:50K	1:15K	1:50K	1:15K
	10	3.0	10.2	12	41	27	91
	15	2.0	6.8	8	27	18	61
	20	1.5	5.1	6	20	14	46
MODERATE SLOPE	25	1.2	4.1	5	16	11	37
	30	1.0	3.4	4	14	9	30
	35	0.9	2.9	3	12	8	26
	40	0.8	2.5	3	10	7	23
	45	0.7	2.3	3	9	6	20
STEEP SLOPE	50	0.6	2.0	2	8	5	18
	55	0.6	1.8	2	7	5	17

This table was prepared using the formula:

$$\text{DISTANCE FOR CONTOUR LINES (mm)} = \frac{\text{CONTOUR INTERVAL (FT.)} \times \text{NUMBER OF CONTOUR INTERVALS MEASURED} \times 30\,480}{\text{\% SLOPE} \times \text{SCALE OF MAP}}$$

e.g. distance between contour lines for a 25% slope on a 1:15 000 map with a contour interval of 50 feet.

$$\text{distance (mm)} = \frac{50 \text{ feet} \times 1 \text{ contour line} \times 30\,480}{25 \times 15\,000} = 4.1 \text{ mm}$$

GLOSSARY

aeolian (eolian) - eroded, transported, or deposited by wind action. Aeolian materials are stone-free, fine grained sands that have been transported by the wind and frequently deposited into characteristic U-shaped or longitudinal dunes.

braided stream - braided stream is one flowing in several dividing and reuniting channels resembling the strands of a braid, the cause of division being the obstruction by sediment deposited by the stream.

colluvium - loose, heterogenous deposits, usually located at the base of a slope or cliff and brought there chiefly by gravity.

cutoff - new and relatively short channel formed when a stream cuts through the neck of an oxbow or horseshoe bend.

drainage density - ratio of total length of channels of all sizes per unit area or frequency of drainage courses per unit area.

duff - fresh forest litter and well-decomposed organic matter and humus on the forest floor.

ephemeral - watercourse (draw) that accommodates flow during snowmelt and rainfall runoff periods only. There is generally no channel development and the stream bottom is usually vegetated.

floodplain- - flat land bordering a stream and subject to periodic flooding by the stream.

gully - small, long, narrow channel eroded by running water, particularly on hillsides and valley sides. Gullies are smaller than ravines, much smaller than valleys, but larger than rills.

intermittent stream- stream that carries water only during some periods of a year. There is some channel development.

LFH - organic soil horizons that develop from leaves, twigs, woody materials, and a minor component of mosses.

L - organic horizon where the original structure of the accumulated organic matter is easily discernible.

F - organic horizon characterized by an accumulation of partly decomposed organic matter.

H - organic horizon characterized by an accumulation of decomposed matter where the original structures are indiscernable. It is frequently intermixed with mineral grains, especially near the mineral horizon.

lateral channel instability - the action of the stream in impinging on one side of its channel and undermining the bank at that point, so that masses of material tumble down to be ultimately disintegrated; at the same time the channel keeps shifting toward the bank which is being undercut.

mass wasting - general term for a variety of processes by which large masses of earth material are moved by gravity either slowly or quickly.

meander scar - usually shallow, crescentic stream-made cuts in the inactive floodplain bordering a stream.

NTS - National Topographic System - five series of the National Topographic System maps exist for Alberta, each with a varying scale and contour interval. These maps indicate spot elevations, contours, surveys, access, hydrograph, wooded areas and cultural features such as schools, parks and cities.

O - organic soil horizon developed mainly from mosses, rushes and woody material.

Of - fibric horizon - least decomposed containing large amounts of identifiable , well - preserved fiber.

Om - mesic horizon - in an intermediate stage of decomposition.

Oh - humic horizon - contains the most highly decomposed organic soil materials.

oxbow - crescent shaped lake formed in an abandoned river bend which has become separated from the main stream by a change in the course of a river.

permanent stream (perennial stream) - stream that flows continuously throughout the year.

Phase 3 map - map of the forest timber types based on Phase 3 inventory.

saprolitic material - disintegrated, somewhat decomposed rock that remains in its original place.

seep - spot where water contained in the ground oozes slowly to the surface, often forming the source of a small stream.

slump - downward slipping of a mass of rock or unconsolidated material of any size, usually along a curved surface of rupture and with backward rotation on a more or less horizontal axis parallel to the cliff or slope from which it descends.

soil creep - slow almost imperceptible but continual movement of the surface soil and rock fragments down slopes, mainly as a result of temperature and moisture changes under the influence of gravity.

spring - place where water flows from a rock or soil upon the land or into a body of surface water.

Strahler watercourse classification - system of classifying the network of stream branches. The classification begins by numbering all non-branching channels on a map as a first order creek. When two first order streams meet, the channel becomes a second order stream; when two second order streams meet, the channel becomes third order; and so on. Fig. 1 shows how the classification is completed.

watershed - watershed is technically defined as any sloping surface that sheds water.

watershed management - the management of lands for optimum production and regulation of water yields and for maximum soil stability, along with other products of the land. Another way to put it is the management of the natural resources of a basin for the production and protection of water supplies and water-based resources, including the control of erosion and floods and the protection of aesthetic values associated with water.

water source area - zones of a watershed where the soils are water saturated or surface flow is occurring, and water is being contributed directly into a water course.

windward length - length of a clearing measured parallel to the predominant wind direction. Often expressed as a multiple of the height (H) of trees surrounding the clearing (eg. 5 H cutblock = 100 m for an average tree height of 20 m).

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